Past Papers Advanced Higher Chemistry

2006 Marking Scheme

Grade Awarded	Mark Required		% candidates achieving grade
	(/125)	%	
A	91+	73%	25.0%
B	76+	61%	26.8%
C	61+	49%	24.0%
D	53+	42%	9.0%
No award	<53	<42%	15.2%

Section:	Multiple Choice	Extended Answer	Investigation
Average Mark:	27.7 /40	33.1 /60	14.9 /25

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MC Qu	Correct Answer	% Correct	Reasoning
1	D	77	☒A No burning inside a sodium vapour lamp ☒B No yellow filter inside a sodium vapour lamp ☒C Energy is adsorbed as electrons move to higher energy levels (electron shells) ☑D Energy is emitted as electrons move to lower energy levels (electron shells)
2	B	59	BF_4^-: Boron has 3 outer electrons + 4 bonding electrons from 4xF + 1 electron from –ve charge. no of electrons = 3+4+1 = 8 electrons → 4 electron pairs (4 bonding pairs) ∴ tetrahedral BF_3: Boron has 3 outer electrons + 3 bonding electrons from 3xF no of electrons = 3 + 3 = 6 electrons → 3 electron pairs (3 bonding pairs) ∴ trigonal planar
3	A	91	Aluminium oxide Al_2O_3 is amphoteric (reacts with acids and bases)
4	B	89	☒A This applies to conductors/metals and superconductors only ☑B Semiconductors increases in conductivity as temperature increases ☒C The Photovoltaic Effect: conductivity of semiconductors increases in the presence of light ☒D More dopant atoms would increase the conductivity instead
5	A	59	☑A Only Cl atom has lone (non-bonding) pairs of electrons → 3 non-bonding pairs on Cl atom ☒B Only O atom has lone (non-bonding) pairs of electrons → 2 non-bonding pairs on O atom ☒C Only N atom has a lone (non-bonding) pair of electrons → 1 non-bonding pair on N atom ☒D Only O atom has lone (non-bonding) pairs of electrons → 2 non-bonding pairs on O atom
6	D	67	lilac flame colour ∴ potassium salt Reacts with water to form hydrogen gas and strong alkaline solution ∴ salt contains hydride ion
7	C	85	☒A This is Heisenberg's Uncertainty Principle ☒B This is the Aufbau principle ☑C Electrons fill up orbitals singly with parallel spins before filling orbitals with 2 electrons ☒D The energy of a bound electron is quantised.
8	B	82	**n**o. of mol of HNO_3 = **v**olume x **c**oncentration = 0.04litres x 2 mol l^{-1} = 0.08mol HNO_3 1 mole of HNO_3 neutralises 1 mole of NH_3 ∴ 0.08mol HNO_3 neutralises 0.08mol of NH_3 ∴ 0.02mol of salt contains 0.08mol of NH_3 ∴ 4 mol of NH_3 per mole of salt
9	B	54	**gfm** AgCl = 107.9 + 35.5 = 143.4g **n**o. of mol = $\frac{\textbf{mass}}{\textbf{gfm}} = \frac{5.74}{143.4}$ = 0.04mol ∴0.02 mol of salt contains 0.04mol of Cl^- ions ∴ formula of salt must be $XxCl_2$
10	A	65	☑A $Ba^{2+}(Cl^-)_2$ contains 1 Ba^{2+} ion per formula unit ∴ 1mol of $BaCl_2$ contains 1mol of positive ions ☒B $BaCl_2$ contains ions not molecules ☒C $BaCl_2$ contains ions not atoms ☒D $Ba^{2+}(Cl^-)_2$ contains 1 Ba^{2+} ion and 2 Cl^- ions per formula unit ∴ 3mol of ions in 1 mole of $BaCl_2$ f.u.
11	C	90	☒A Increase in temp favours endothermic reaction ∴ reverse reaction is endothermic ☒B Removal of a reactant (O_2) moves equilibrium to the LEFT ☑C Increase in pressure favours pressure-reducing equation: Forward reaction 3vol → 2vol of gas ☒D Catalysts do no alter the position of equilibrium
12	A	77	☑A Solubility of the solute X may vary differently in either solvent with temperature ☒B Volume of water does not alter concentration of solute X ∴ more water means more solute X ☒C Increased mass of solute X in water layer will mean more X going into upper layer ☒D Increased mass of solute X will mean same % separation of X between layers
13	D	61	$pH = pK_a - \log\frac{[acid]}{[salt]} = 4.76 - \log\frac{0.1}{0.2} = 4.76 - \log(0.5)$ $= 4.76 - (-0.301)$ $= 5.06$
14	D	55	☒A $[H^+]$ = 0.1mol l^{-1} = 10^{-1} ∴ pH = $-\log_{10}[H^+] = -\log_{10}[10^{-1}] = -(-1) = 1$ ☒B Na**OH** present = 0.002mol and CH_3COO**H** present = 0.002mol ∴ complete neutralisation ☒C pH of strong acid is lower than pH of weak acid at same conc. due to increased H^+ dissociation. ☑D The lower the K_a value the weaker the acid (also higher the pK_a value the weaker the acid)

15	C	48	weak acid v. weak alkali titrations do not give a sharp colour change to get an accurate end point
16	C	55	Bonds broken: 1x H–H bond = +432kJ mol^{-1} (now +436kJ in current data booklet) Bonds formed: 1x H–Cl bond = -428 kJ mol^{-1} (now -432kJ in current data booklet) Enthalpy change = +432kJ mol^{-1} + (-428kJ mol^{-1}) = +4kJ mol^{-1} (+436 + (-432) = +4kJ mol^{-1} too!)
17	D	28	☒A Enthalpy of Formation for CO only ☒B Enthalpy of Formation for H_2O_2 only ☒C Enthalpy of Formation for Na_2O but not enthalpy of Combustion of Na as 2 mol of Na burned. ☑D Enthalpy of Formation for MgO and Enthalpy of Combustion for Mg.
18	A	75	☑A Lattice enthalpy: gaseous ions turn into the ionic solid ☒B Equation contains gaseous atoms turning into ionic solid not ions ☒C Equation contains solids and diatomic molecules not gaseous ions ☒D Equation contains solids not gaseous ions.
19	B	66	☒A Cl–Cl bond must be broken before ionisation steps [$Cl_{2(g)} \rightarrow 2Cl_{(g)}$] ☑B The electron affinity enthalpy for Cl [$Cl_{(g)} + e^- \rightarrow Cl^-_{(g)}$] is required not 1st Ionisation Energy ☒C 1st Ionisation energy for Na is required [$Na_{(g)} \rightarrow Na^+_{(g)} + e^-$] ☒D Enthalpy of formation for NaCl required [$Na_{(s)} + \frac{1}{2}Cl_{2(g)} \rightarrow NaCl_{(s)}$]
20	A	79	☑A Decrease in entropy means decrease in disorder: 2 reactant gases react to form 1 product gas ☒B Increase in entropy/disorder: number of particles double as reaction proceeds ☒C Increase in entropy/disorder: Solid releases a gas as reaction proceeds ☒D Increase in entropy/disorder: Solid reacts and all products are gases
21	B	67	☒A Position of equilibrium (to the right) is no indication of speed of the reaction ☑B High value of equilibrium constant indicates feasibility of reaction ☒C Equilibrium constant does not give any details of enthalpy change (exothermic/endothermic) ☒D Equilibrium constant does not give any details of enthalpy change (exothermic/endothermic)
22	B	70	Upper equation of any pair of line is reversed and we want Ti + $O_2 \rightarrow TiO_2$ line to be reversed to produce Ti metal. Only Mg line is below Ti line at 1500K (H, Na & C lines are above Ti line at 1500K)
23	D	64	☒A Oxidation: $Ni_{(s)} \rightarrow Ni^{2+}_{(aq)} + 2e^-$ as nickel is higher up the electrochemical series ☒B Ni^{2+} ions are not changed in this cell ☒C Ag atoms are not changed in this cell ☑D Reduction: $2Ag^+_{(aq)} + 2e^- \rightarrow 2Ag_{(s)}$ as silver is below nickel in the electrochemical series
24	A	71	Kinetics of the rate determining (slow) step are key to answer Slow step: 1x NO and 1xCl_2 hence both reactants have 1st order kinetics $\therefore$rate = $[NO]^1[Cl_2]^1 = [NO][Cl_2]$
25	B	81	Order of Reaction for P: Compare experiments 1+3 → 2x[P] does not change time $\therefore$ zero order Order of Reaction for Q: Compare experiments 1+2 → 2x[Q] halves time for reaction $\therefore$ 1st order $\therefore$rate = $[P]^0[Q]^1 \therefore$ rate = [Q]
26	C	85	Reaction 1: substitution reaction $C_3H_8 + Br_2 \rightarrow C_3H_7Br + H\text{-}Br$ (in the presence of light) Reaction 2: substitution reaction as -Br group is replaced by –OH group Reaction 3: dehydration reaction as water is removed and a C=C double bond is created.
27	B	60	The +ve cyclic ion intermediate is attracted to the Cl^- or Br^- ions present. It will react with either.
28	A	79	<table><tr><td>Inside Bond</td><td>C-H</td><td>C-C</td><td>C=C</td><td>C≡C</td></tr><tr><td>Sigma bonds</td><td>1</td><td>1</td><td>1</td><td>1</td></tr><tr><td>Pi Bonds</td><td>0</td><td>0</td><td>1</td><td>2</td></tr></table> <table><tr><td>Inside Molecule</td><td>4 x C-H bond</td><td>1 x C-C bond</td><td>1 x C=C bond</td><td>1 x C≡C bond</td><td>Total</td></tr><tr><td>Sigma bonds</td><td>4</td><td>1</td><td>1</td><td>1</td><td>7</td></tr><tr><td>Pi Bonds</td><td>0</td><td>0</td><td>1</td><td>2</td><td>3</td></tr></table>
29	C	78	☒A no sp^2 hybridisation in alkanes (sp^2 hybridisation is found in alkenes) ☒B no sp^2 hybridisation in alkanes (sp^2 hybridisation is found in alkenes) ☑C only sigma (single) bonds in alkanes and only sp^3 hybridisation in alkanes ☒D no pi bonds in alkanes (pi bonds are found in C≡C bonds and C=C bonds)
30	A	90	☑A Termination Step: no free radicals in products to continue reaction. ☒B Propagation Step: started by a free radical & a free radical is produced to continue the reaction ☒C Propagation Step: started by a free radical & a free radical is produced to continue the reaction ☒D Initiation Step: No free radicals in reactants but free radicals produced to continue reaction.
31	C	74	☒A Ethers, like ethoxyethane, are carbon-based compounds which are very flammable ☒B ethoxyethane $CH_3CH_2OCH_2CH_3$ and butan-1-ol $CH_3CH_2CH_2CH_2OH$ are isomers (formula $C_4H_{10}O$) ☑C butan-1-ol has a higher boiling point than ethoxyethane due to hydrogen bonding ☒D $CH_3CH_2O^-Na^+ + BrCH_2CH_3 \rightarrow NaBr + CH_3CH_2OCH_2CH_3$ (ethoxyethane)

32	B	73	Molecule must have two acid –COOH groups to produce polyester with ethane-1,2-diol
33	B	65	☒A ketones do not oxidise. ☑B aldehydes are oxidised by Tollen's Reagent ☒C Primary alcohols are <u>not</u> oxidised by Tollen's Reagent ☒D Tertiary alcohols do not oxidise
34	C	46	☒A CH_3CH_2OH is an alcohol and is neutral ☒B C_6H_5OH (Phenol) is acidic as H^+ ions dissociates from phenol molecule ☑C $CH_3CH_2NH_2$ is a basic molecule as H^+ ion forms dative covalent bond to form $CH_3CH_2NH_3^+$ ☒D $C_6H_5NH_2$ (Phenylamine) is not as basic as $CH_3CH_2NH_2$ as lone pair is withdrawn from N into delocalised electrons of the phenyl group
35	C	20	$C_{10}H_8$ gains a maximum of 10 hydrogen atoms during hydrogenation 1 mol of $C_{10}H_8$ = (10x12) + (8x1) = 120 + 8 = 128g no. of mol = $\frac{\textbf{mass}}{\textbf{gfm}} = \frac{12.8}{128}$ = 0.1 mol $C_{10}H_8 + 5H_2 \rightarrow C_{10}H_{18}$: 1 mol of $C_{10}H_8$ reacts with 5 mol of H_2 to form 1 mol of $C_{10}H_{18}$ 1mol 5mol 0.1mol 0.5mol
36	D	78	☒A no C=C double bond in compound ∴no geometric isomer ☒B need two –Cl groups across a C=C double bond to become a geometric isomer ☒C -Cl groups need to be different carbons not same carbon ☑D this structure has 2 geometric isomers: *trans*-1,2-dichloroethene and *cis*-1,2-dichloroethene
37	A	68	<table><tr><td>Elements</td><td>C</td><td>H</td><td>O</td></tr><tr><td>percentage of element</td><td>37.5%</td><td>12.5%</td><td>50.0%</td></tr><tr><td>Divide mass by RAM</td><td>$= \frac{37.5}{12}$ = 3.125</td><td>$= \frac{12.5}{1}$ = 12.5</td><td>$= \frac{50.0}{16}$ = 3.125</td></tr><tr><td>Divide through by smallest value</td><td>$= \frac{3.125}{3.125}$ = 1</td><td>$= \frac{12.5}{3.125}$ = 4</td><td>$= \frac{3.125}{3.125}$ = 1</td></tr></table>
38	D	72	Heaviest (m/z) peak (found on right hand side) gives formula mass of compound = 58 ☒A Propane C_3H_8 has formula mass = 44 ☒B Propan-1-ol $CH_3CH_2CH_2OH$ has a formula mass of 60 ☒C Propan-2-ol $CH_3CH(OH)CH_3$ has a formula mass of 60 ☑D Propanone CH_3COCH_3 has a formula mass of 58
39	C	80	Infra-red Absorption Spectroscopy involves the bonds within molecules absorbing of the energy of the infra-red wavelength region to stretch the bonds. Where there are absorptions of certain IR wavelengths, the trace shows downward peaks where the IR has been absorbed.
40	A	90	☑A agonists have an pharmacological effect inside the cell (relaxes muscles) ☒B Antagonists have no pharmacological effect in the cell (wouldn't relax muscles) ☒C Pharmacaphores: 3D shapes which agonist/antagonist molecules have in common with natural substrate ☒D Drugs like salbutamol bind with receptors to cause an effect in the cell.

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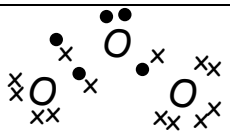
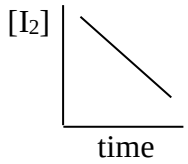
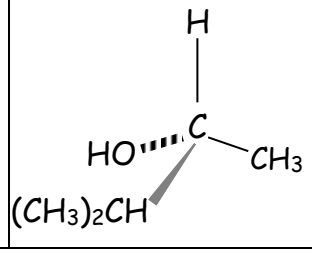
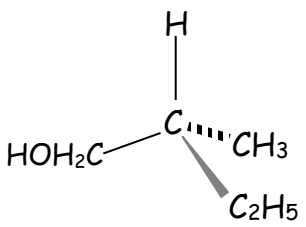
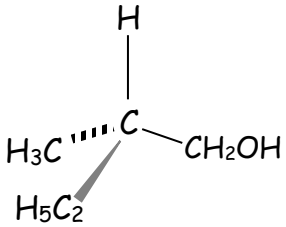
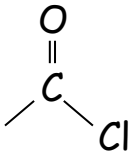
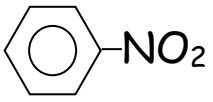
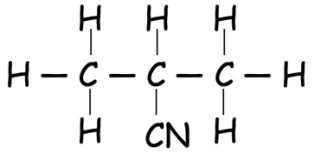
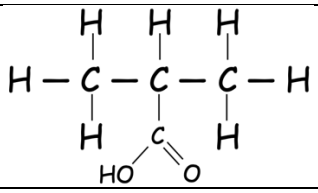
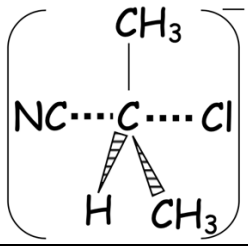
Long Qu	Answer	Reasoning
1a(i)	+178.3 kJ mol^{-1}	$\Delta H^\circ_{reaction} = \Sigma\Delta H^\circ_f$ (products) – $\Sigma\Delta H^\circ_f$ (reactants) = (-393.5 - 635.1) – (-1206.9) = +178.3kJ mol^{-1}
1a(ii)	+159 J K^{-1} mol^{-1}	$\Delta S^\circ_{reaction} = \Sigma S^\circ_f$ (products) – ΣS°_f (reactants) = (213.8 + 38.1) – (92.9) = +159 J K^{-1} mol^{-1}
1a(iii)	1121.4K	The reaction becomes thermodynamically feasible when $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ = 0$ $\therefore T\Delta S^\circ = \Delta H^\circ \quad \therefore T = \frac{\Delta H^\circ}{\Delta S^\circ} = \frac{178.3 \times 1000 \text{ J mol}^{-1}}{159 \text{ J K}^{-1} \text{ mol}^{-1}} = 1121.4K$
1b(i)	+5	(4 x Phosphorus Oxidation No) + (10 x Oxygen Oxidation No) = 0 (4 x Phosphorus Oxidation No) + (10 x -2) = 0 (4 x Phosphorus Oxidation No) = +20 $\quad \therefore$ Phosphorus Oxid^n N^o = $^{+20}/_4$ = +5
1b(ii)	Calcium phosphate	P_4O_{10} is a non-metal oxide $\therefore$ dissolves in water to form phosphoric acid H_3PO_4 Neutralisation of calcium oxide + phosphoric acid forms calcium phosphate + water
2a	Colourless to purple	MnO_4^- ions are purple. MnO_4^- ions are titrated from burette into reaction. MnO_4^- ions are immediately reacted away with oxalate ions are present. Once the oxalate ions are all been used up, MnO_4^- ions will remain and change the colour in flask to purple.
2b		❶ $C_2O_4^{2-} \rightarrow 2CO_2 + 2e^-$ ❷ $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$ ❶ x5 $5C_2O_4^{2-} \rightarrow 10CO_2 + \cancel{10e^-}$ ❷ x2 $2MnO_4^- + 16H^+ + \cancel{10e^-} \rightarrow 2Mn^{2+} + 8H_2O$ ❶'+❷' $2MnO_4^- + 16H^+ + 5C_2O_4^{2-} \rightarrow 2Mn^{2+} + 8H_2O + 10CO_2$
2c	0.045 mol l^{-1}	**n**o. of mol of MnO_4^- = **v**olume x **c**oncentration = 0.0225$_{litres}$ x 0.025 mol l^{-1} = 0.00045 mol $2MnO_4^- + 16H^+ + 5C_2O_4^{2-} \rightarrow 2Mn^{2+} + 8H_2O + 10CO_2$ 2mol 5mol 0.00045mol. 0.001125mol **c**oncentration = $\frac{\text{**n**o. of mol}}{\text{**v**olume}} = \frac{0.001125 \text{ mol}}{0.025 \text{ litres}} = 0.045 \text{ mol l}^{-1}$
3a	$1s^2 2s^2 2p^6$	Neon atoms have 10 electrons. (2+2+6=10) Neon is a Noble Gas has full orbitals (s holds 2 electrons and p holds 6 electrons)
3b	of equal energy	Electrons in the same orbital are of equal energy as the orbital is at a fixed distance from the nucleus.
3c	figure of 8 shape	2nd (Angular Momentum) Quantum Number has value of l=0, 1, 2 or 3 for s, p, d and f respectively. l=1 is the p orbital. p_x, p_y and p_z orbitals all have a figure of 8 shape (∞).
3d	n=3 l=0	n=3: sodium is the 1st element in the next period as n=2 is now a full shell l=0: s-orbitals fill up first in the n=3 shell → l=0
4a	241nm	$E = \frac{L \times h \times c}{\lambda} \quad \therefore \lambda = \frac{L \times h \times c}{E} = \frac{6.02\times10^{23}\text{mol}^{-1} \times 6.63\times10^{-34} \text{ J s} \times 3\times10^8 \text{ m s}^{-1}}{497 \times 1000 \text{ J mol}^{-1}}$ $= 2.41 \times 10^{-7}$ m = 241nm
4b(i)	-391kJ mol^{-1}	Reaction ❶x-1: $O_3 \rightarrow O + O_2$ $\quad \Delta H$= +106 kJ mol^{-1} Reaction ❷: $O + O \rightarrow O_2$ $\quad \underline{\Delta H = -497 \text{ kJ mol}^{-1}}$ Add ❶'+❷: $O + O_3 \rightarrow O_2 + O_2$ $\quad \underline{\Delta H = -391 \text{ kJ mol}^{-1}}$
4b(ii)		This diagram or its mirror image is acceptable. All dots is also acceptable

5a	$K_a = \frac{[H^+][HPO_4^{2-}]}{[H_2PO_4^-]}$	K_a equilibrium equation has concentrations of product(s) on top and concentrations of reactant(s) on bottom of equation
5b	4.1	pH = $\frac{1}{2}pK_a - \frac{1}{2}\log_{10}c$ = $(\frac{1}{2}\times 7.2) - \frac{1}{2}\log_{10}(0.1)$ = 3.6. – (-0.5) = 4.1
5c	Accepts a H^+ ion	An acid is any substance capable of donating a proton (H^+) A base is any substance capable of accepting a proton (H^+)
6a	Hydrogen: ΔH= -143 kJ Petrol: ΔH= -44.7 kJ	gfm H_2 = (2x1) = 2g no. of mol = $\frac{\text{mass}}{\text{gfm}} = \frac{1g}{2g\ mol^{-1}} = 0.5mol$ 1 mol = -286kJ 0.5mol = $-286 \times {}^{0.5}/_{1} = -143kJ$ gfm C_8H_{18} = (8x12)+(18x1) = 96+18 = 114g no. of mol = $\frac{\text{mass}}{\text{gfm}} = \frac{1g}{114g\ mol^{-1}} = 0.0088mol$ 1 mol = -5100 kJ 0.5mol = $-5100 \times {}^{0.5}/_{1} = -44.7$ kJ
6b(i)	$O_2(g)+4H^+(aq)+4e^- \rightarrow 2H_2O(l)$	$O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l)$ is found in the data booklet p12
6b(ii)	0.03V	Oxidation: $CH_3OH + H_2O \rightarrow CO_2 + 6H^+ + 6e^-$ $E^o = X$ Reduction: $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$ $E^o = 1.23V$ Redox: $CH_3OH + 1\frac{1}{2}O_2 \rightarrow CO_2 + 2H_2O$ $E^o = 1.20V$ Oxidation E^o : 1.20V = 1.23V + X $\therefore$ X = 1.20V – 1.23V = -0.03V $\therefore$Reduction E^o: +0.03V (NB multiplying Reduction equation by $1\frac{1}{2}$ does not change E^o)
6b(iii)	-694.8kJ mol^{-1}	$\Delta G^o = -nFE^o = -6 \times 96500 \times 1.20 = -694800\ J\ mol^{-1} = -694.8\ kJ\ mol^{-1}$
7a	[propanone] and $[H^+]$ are much higher than $[I_2]$	Propanone and acid are in excess as it is iodine that is being investigated.
7b		Concentration of Iodine decreases with time linearly i.e. zero order. I_2 does not appear in the rate determining (slow) step. If reactant is zero order then the line is linear as changing the concentration of I_2 does not change the reaction rate. If reaction rate is constant then the gradient of the line is constant which results in a straight line.
7c	2nd order	I_2 is zero order (i.e x=0) CH_3COCH_3 is 1st order and H^+ is 1st order → Overall order = 0+1+1 = 2
7d	$mol^{-1}\ l\ s^{-1}$ or $l\ mol^{-1}s^{-1}$	Rate = $k\ [CH_3COCH_3][H^+]$ $k = \frac{\text{rate}}{[CH_3COCH_3][H^+]} = \frac{mol\ l^{-1}\ s^{-1}}{mol\ l^{-1} \times mol\ l^{-1}} = l\ mol^{-1}\ s^{-1}$
8a	Any answer from:	(ortho)phosphoric acid | aluminium oxide | conc sulphuric acid
8b	Cyclohexanol has hydrogen bonding	-OH bond in cyclohexanol leads to hydrogen bonding between molecules and elevates the boiling point. Cyclohexene is a non-polar hydrocarbon with no hydrogen bonding
8c	NaCl is denser or helps separate mixture better	Cyclohexene is less soluble/insoluble in saturated NaCl solution than in water
8d	Make derivative (1 mark) Test Melting point and compare value (1 mark)	Brady's Reagent (2,4-dinitrophenylhydrazine) makes a solid derivative with aldehydes and ketones. These solid derivatives have melting points which can be directly compared to theoretical values to reveal the identity of the original aldehyde/ketone.
9a	Answer C	$(CH_3)_2(C_2H_5)COH$ has 3 carbons attached to the carbon with the –OH group
9b		There are many ways to draw this shape but it is safest to draw the mirror image of the original diagram. If the diagram is not a direct mirror image then two corners should be the same arrangement and the other two corners should be swapped positions.

9c	Either from:	 or  or similar
10a	propan-1-ol has the shortest carbon chain	Hydrocarbon part of the molecule is hydrophobic. Hydroxyl (-OH) part of the molecule is hydrophilic and forms hydrogen bonds with water. The larger the hydrocarbon part of the molecule, the lower the solubility of the alcohol in water.
10b(i)	Acid chlorides	Acid chlorides have the structure:  Acid chlorides react faster and give a higher yield of ester.
10b(ii)	Faster reaction or higher yield	Equilibrium of esterification reaction using acid chlorides lies much further to the right/products side than using carboxylic acids.
11a(i)	Iron (III) Bromide or Aluminium Bromide	$AlBr_3$, $AlCl_3$, $FeBr_3$ and $FeCl_3$ are all catalysts for this reaction.
11a(ii)	nitrobenzene	HNO_3 / H_2SO_4 will react with benzene to substitute a nitro group onto the benzene ring. More than one nitro group can be substituted onto benzene ring. 
11a(iii)	Sulphonation	Adding $-SO_3H$ groups to benzene using SO_3/conc. H_2SO_4 is called Sulphonation
11b	Delocalised electrons in ring are not able to transfer molecules	In graphite, each carbon atom has an electron not taking part in bonding which can transfer from atom to atom during electrical conduction. The delocalised electrons in benzene are not localised to any particular atom in benzene but are attached to particular molecules and cannot jump to neighbouring molecules.
12a	$CH_3CH(CN)CH_3$	Substitution reaction: -C≡N group replaces the -Cl group. 
12b	2-methylpropanoic acid	
12c(i)	2-methylpropan-1-ol	Needs to be primary alcohol to oxidised to a carboxylic acid → 2-methylpropan-1-ol To form 2-methylpropanoic acid, alcohol needs to 2-methylpropan(anol) carbon shape
12c(ii)	Any Answer from:	acidified (potassium) dichromate solution / acidified (potassium) permanganate solution / (hot) copper (II) oxide
12d(i)	S - substitution N - nucleophilic 2 – 2 particles in RDS	Nucleophilic substitution reaction where 2 colliding particles are involved in the slowest step (rate determining step)
12d(ii)		CN^- ion attacks ion from opposite side on molecule from –Cl group. The bond to CN group starts to form and the bond to the Cl starts to break. The whole intermediate molecule has a 1- charge
13a	Graph showing:	Peak at 2.1-2.8 (this peak is 3x higher that other peak due 3H atoms in CH_3- group) Peak at 9.6-10.1 (this peak is much smaller than other peak as 1H in –CHO group)
13b	TMS	Tetramethylsilane (TMS) is the standard reference chemical used to calibrate the NMR and is always given a chemical shift of zero.